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H01B 12/02**C01G 1/00****C01G 29/00****C22C 1/10****C22C 5/10****H01B 13/00**(21)Application number : **07-272591**(71)Applicant : **HITACHI CABLE LTD**(22)Date of filing : **20.10.1995**(72)Inventor : **SATO JUNICHI
NOMOTO AKIRA
NOMURA KATSUMI****(54) OXIDE SUPERCONDUCTING COMPOSITE MATERIAL AND ITS MANUFACTURE****(57)Abstract:**

PROBLEM TO BE SOLVED: To provide high strength oxide superconducting composite material in which the deterioration of superconductivity characteristics is little by lessening the oxygen containing amount change rate of metal material before and after the superconducting heat treatment in oxide superconducting composite material.

SOLUTION: After compounding an oxide superconductor and metal material and plastic working the same, superconducting treatment is conducted. This time, the compounding is conducted using strengthening treated dispersion strengthening type metal material, and the oxygen containing amount change rate of the metal material before and after the superconducting heat treatment is set to 100% or less. As the metal material silver base alloy containing 0.01 to 5 atom % of at least one kind of Cd, Hf, Mg, Mn, Ni, Sn, Ti, Zr is used. As the oxide superconductor a Bi group composed of Bi, Sr, Ca, and Cu is used. As the composite material tape-like wire rods are used. The compounding is conducted in a powder in tube method, a jerry roll method, and the like.

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CLAIMS

[Claim]

[Claim 1] The oxide-superconductivity composite to which it is the oxide-superconductivity composite which consists of an oxides superconductors and metal material, and the rate of change of the oxygen content in the aforementioned metal material is characterized by being 100% or less before and after superconductivity-ized processing.

[Claim 2] An oxide-superconductivity composite given in the claim 1 whose metal material is a dispersion-strengthening type silver machine alloy.

[Claim 3] An oxide-superconductivity composite given in the claim 2 which is the silver machine alloy with which a silver machine alloy contains at least one sort in Cd, Hf, Mg, Mn, nickel, Sn, Ti, and Zr in the domain of 0.01 - pentatomic %.

[Claim 4] An oxide-superconductivity composite given in any 1 of the claim 1 which is the thing of Bi system which a main oxide superconductor becomes from Bi, Sr, calcium, and Cu at least, or the claims 3.

[Claim 5] An oxide-superconductivity composite given in the claim 4 of Bi-2212 phase and Bi-2223 phase whose main oxide superconductor is either at least.

[Claim 6] An oxide-superconductivity composite given in the claim 5 whose composite is a tape-like wire rod.

[Claim 7] The manufacture technique of the oxide-superconductivity composite characterized by composite-izing in the technique of performing superconductivity-ized heat treatment, using the dispersion-strengthening type metal material to which strengthening processing was performed, and carrying out the rate of change of the oxygen content of the aforementioned metal material before and after superconductivity-ized heat treatment to 100% or less after composite-izing an oxides superconductors and metal material and performing plastic working.

[Claim 8] Technique given in the claim 7 whose dispersion-strengthening type metal material is an internal-oxidation type silver machine alloy.

[Claim 9] Technique given in the claim 8 whose silver machine alloy is a silver machine alloy to carry out 0.01 - pentatomic % inclusion about at least one sort in Cd, Hf, Mg, Mn, nickel, Sn, Ti, and Zr.

[Claim 10] Technique given in any 1 of the claim 7 whose composite-ization is the powder in tube method, or the claims 9.

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DETAILED DESCRIPTION

[Detailed description]

[0001]

[The technical field to which invention belongs] this invention relates to an oxide-superconductivity composite and its manufacture technique.

[0002]

[Prior art] Generally virgin silver is used from the place said that there is little reactivity with a superconductor as the lagging material and base material of oxide-superconductivity material (for example, the 53rd spring cryogenic engineering in the 1995 fiscal year and collection P77 of superconductivity society lecture schemata).

[0003] However, from strength of virgin silver being very weak, the strength of the obtained oxide-superconductivity composite is weak, and it waits eagerly for the high intensity oxide-superconductivity composite.

[0004] The attempt in which oxide-superconductivity material will be high-intensity-ized by transposing Ag to Ag machine alloy as the one technique is made. For example, to prepare the pipe of the Ag-Mg alloy by which strengthening processing is not carried out, and for it to be filled up with the powder of an oxides superconductors into the pipe, to extrude to the composite, to carry out the internal oxidation of the Ag-Mg alloy a tape-like manipulation of a reduction-of-area manipulation of drawing, a swaging, etc. and rolling, a press, etc. and by [at least one / or more] superconductivity--ization-heat-treating, and to strengthen is tried.

[0005]

[Object of the Invention] Since the oxygen in the ambient atmosphere of superconductivity-ized heat treatment reacts with the alloying element in Ag machine alloy and an internal oxidation is carried out, when a high intensity oxide-superconductivity composite is produced with the above mentioned technique, although Ag machine alloy is strengthened, there are the following problems.

[0006] (1) Since the internal oxidation of Ag machine alloy is not fully performed in order that a superconductor may react, as for the oxygen in the ambient atmosphere, a high intensity oxide-superconductivity composite is not obtained.

[0007] (2) The alloying element in Ag machine alloy which remained, without performing an internal oxidation reacts with a superconductor, and deteriorates the critical current density (Jc) of the obtained oxide-superconductivity composite.

[0008] (3) When eaten by the internal oxidation of Ag machine alloy, cause the shortage of oxygen to a superconductor and Jc of the obtained oxide-superconductivity composite deteriorates.

[0009] The purpose of this invention is to obtain the high intensity oxide-superconductivity composite without a degradation of a superconductivity property.

[0010]

[The means for solving a technical problem] The summary of this invention uses the metal material to which strengthening processing was performed beforehand as a lagging material or a base material, and is to have made small the rate of change of the oxygen content of the aforementioned metal material before and after superconductivity-ized heat treatment.

[0011]

[Gestalt of implementation of invention] As for the oxide-superconductivity composite concerning this invention, the rate of change of the oxygen content of metal material is made to become small before and after the superconductivity-ized heat treatment.

[0012] In order to obtain such a composite, in this invention, as a lagging material or a base material, strengthening processing of the silver machine alloys, such as for example, an Ag-Mg alloy, an Ag-Mg-nickel alloy, an Ag-Mg-Zr alloy, and an Ag-Sn alloy, is carried out beforehand, a stable and detailed phase, for example, an oxide phase, is distributed uniformly, a thing is used, and it is made for the rate of change of the oxygen content in an alloy to be 100% Proof stress can obtain the high intensity oxide-superconductivity composite of 50 or more MPas by doing so 0.2% which a phase stable [the time of superconductivity-ized heat treatment] in the amount of oxygen in metal material hardly changing and detailed does not react to with an oxides superconductors, and does not have a degradation of a superconductivity property.

[0013] In order to obtain the above silver machine alloys, Cd, Mn, Ti, and Hf can be used out of Mg, nickel, Sn, and Zr which were described above as an element which can be added to Ag.

[0014] Although these elements have the effect which suppresses grain growth, since there is no effect of high-intensity-izing when at least one sort of the contents are under 0.01 atom %s, the reaction with oxide-superconductivity material will become

remarkable if pentatomic % is exceeded, and a superconductivity property is degraded greatly, as for the content, it is desirable that it is the domain of 0.01 - pentatomic %.

[0015] Especially as a device of strengthening, it is not limited [precipitation strengthenings /, such as intermetallic compounds other than an oxide dispersion strengthening (internal oxidation) and an oxide,] among dispersion strengthenings.

[0016] Although it is heat-treated in the ambient atmosphere containing oxygen after composite-izing the metal material by which strengthening processing was carried out with an oxides superconductors and carrying out plastic working, as for heat treatment in that case, the ambient atmosphere of 0.01-10atm is adopted for 700-950 degrees C and the oxygen tension by which an oxides superconductors is superconductivity-ized.

[0017] in addition, as the production technique of the compound component of a lagging material or the metal material as a base material, and an oxides superconductors The powder in tube method, a Jelly roll process, a dip coating method, a doctor blade method, A spraying process, a plasma-metal-spray method, a screen printing, a vacuum deposition, CVD, the sputtering method, Neither, such as the laser ablation method, interferes, as the structure, it is not limited to the combination with one oxide-superconductivity material, one lagging material, or a base material, but the combination with the material of two or more material and others can be adopted.

[0018] Moreover, as a modality of oxides superconductors, they are 2212 which contains Bi at least, 2212, 2223, 1212, 1201 and 1223 which contain Tl at least 2223 phase, 1234 phases, and ReBa₂ Cu₃ O_y. A phase (Re=Y, La, Nd, Eu, Dy, Gd, Ho, Er, Tm, Yb, Lu), Hg system, etc. are mentioned.

[0019] In addition, the composite in this invention says a wire rod, a conductor, or them for set-izing, the composite-ized component, and a magnet, a coil, a cable, a busbar, a current lead, a magnetic shielding, a current limiter, a permanent-current switch, etc. are raised as the application.

[0020] As a configuration of the aforementioned wire rod, a wire, a straight angle line, a tape line, a single core wire, many core wires, *****, a spiral-like line, a stranded wire, etc. may be any.

[0021]

[Example] Below, the example of this invention is explained.

[0022] (Example) It is Bi₂ Sr₂ calcium₁ Cu₂ O_x as composition. They are Bi₂ O₃, SrCO₃, and CaCO₃ so that it may be obtained. And after having mixed each powder of CuO and heat-treating this 820 degrees C in the atmospheric air for -20 hours, it was ground and the precursor powder of Bi-2212 phase was obtained.

[0023] The silver machine alloy pipe with an outer diameter [of 8mm] and a bore of 6mm was created from the material which melted and cast the alloy which added Mg and nickel to pure Ag in the RF lead smelter, and obtained it in Ar ***** ambient atmosphere on the other hand. When ICP analysis of the silver machine alloy pipe was carried out, Mg was 1.7 atoms % and nickel was 1.9 atoms %. Only the pipe of A performed 820 degree-C processing [dispersion-strengthening] of -4 hours in the atmospheric air, having used [carved this silver machine alloy pipe into two / with a length of 300mm /, and] another side as B having used one side as A.

[0024] Next, after having carried out tapping restoration of the precursor powder described above, respectively and carrying out a wire drawing to both pipe of A and B to the outer diameter of 1mm, it was processed with rolling with 0.12mm [in thickness], and a width of face of 3mm in the shape of a tape. Then, each tape-like composite was annealed to 833 degrees C with the cooling rate of 5 degrees C/hour after 883 degree-C-10 minute hold in the atmospheric air, and also it held for 1 hour and furnace cooling was carried out.

[0025] It asked for change of the amount of oxygen in the silver alloy before and behind critical-current-density (J_c) 0.2% heat treatment [proof stress and superconductivity-ized] as follows about each obtained tape-like composite.

[0026] J_c is [the tension test in a room temperature and the change of the amount of oxygen of the 1microv //cm / Criterion and 0.2% proof stress] secondary ion mass spectrometers (SIMS) in a direct-current four probe method in 4.2K and 0T. The result is shown in Table 1.

[0027]

[Table 1]

試料	J _c (A/cm ²)	0.2%耐力 (MPa)	銀合金中の酸素量(at%)	
			超電導化熱処理前	超電導化熱処理後
A	80000	530	3.57	3.57
B	15000	280	0.01	1.59

[0028] J_c and 0.2% proof stress of a starting [this invention] sample are high. Moreover, the amount of oxygen in Ag alloy is not changing before and after superconductivity-ized heat treatment, either. As for the sample of B which is an example of a comparison, J_c is falling sharply to it, and 0.2% proof stress is 1/2 of A. Moreover, the amount of oxygen in Ag alloy also increased sharply after superconductivity-ized heat treatment.

[0029] The sample after superconductivity-ized heat treatment was embedded to the resin, was ground, and the cross section was observed by the scanning electron microscope. The detailed sludge by which Mg, nickel, and O are detected in Ag alloy in sample A was distributing. This organization was the almost same organization as superconductivity-ized heat treatment before.

Moreover, there were few unusual appearances in oxide-superconductivity material.

[0030] In sample B, the phase from which Mg, big and rough nickel, and big and rough O are detected near the sea surface with a superconductor with an object by detailed ** by which Mg, nickel, and O are detected in Ag alloy was accepted. Moreover, many unusual appearances which contain Mg, nickel, or both also in oxide-superconductivity material accepted. Namely, since it distributes uniformly by performing dispersion-strengthening processing of Ag alloy beforehand as an oxide detailed [the point or element of Mg, nickel, etc.] in Ag, and stable, as for the amount of oxygen in Ag alloy, the time of superconductivity-ized heat treatment does not change, either. Moreover, in that case, an oxides superconductors and oxides, such as Mg in Ag and nickel, do not react, and Jc does not deteriorate. Although additives, such as Mg in Ag alloy and nickel, react with oxygen in the case of superconductivity-ized heat treatment in the case of the example of a comparison and a part serves as a detailed oxide in Ag to it, while an oxides superconductors runs short of oxygen for the reason, a part of additive will react with an oxides superconductors, and it will generate an unusual appearance. Moreover, the amount of oxygen increases greatly in order. Furthermore, sufficient strength will be obtained in order for a part of alloying element in Ag alloy to oxidize.

[0031]

[Effect of the invention] According to this invention, a high intensity oxide-superconductivity compound component can be obtained, and there is an advantage which can provide various intended use with a useful high intensity compound component cheaply so that clearly from the above explanation.

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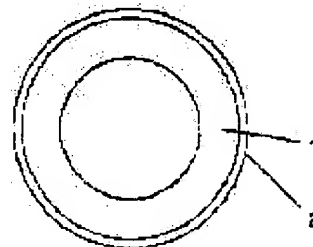
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(54) CARRIER FOR SUPERCONDUCTING COIL

(57)Abstract:

PURPOSE: To provide a carrier for a superconducting coil in which high rigidity and superior insulation characteristic are guaranteed.

CONSTITUTION: A carrier for a superconducting coil provided with a winding body, comprising a ceramic oxide superconducting wire rod requires thermal expansion coefficient equal to the expansion coefficient of the superconducting wire rod. So the carrier for the superconducting coil contains, as a raw material, an alloy, mainly containing silver, in which an oxide dispersed/hardened or which can harden, in an inner part 1 of the carrier, and has an auxiliary layer 2, an oxide-covering layer, tightly adhering to the alloy. In the carrier, the rigidity is enhanced by the former, and an insulating layer is provided by the later.



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CLAIMS

[Claim]

[Claim 1] Support for superconducting coils characterized by carrying out the dispersion hardening of the oxide with which support mainly consists of silver as a material in the support for the superconducting coil which has **** which consists of long superconduction complex, or including the alloy which can be hardened.

[Claim 2] Support of the claim 1 publication characterized by being the Ag-Mg or Ag-Mg-nickel alloy with which a silver alloy contains Mg 0.1 to 0.25% of the weight, and contains the remaining silver for nickel 0.1 to 0.25% of the weight.

[Claim 3] Support of the claim 1 publication characterized by being the Ag-Mn-nickel alloy with which a silver alloy combines Mn and nickel, and contains the remaining silver 0.5 to 1.5% of the weight.

[Claim 4] Support of the claim 1 publication characterized by being the Ag-aluminum alloy with which a silver alloy contains the remaining silver for aluminum 0.05 to 0.6% of the weight.

[Claim 5] The claim 1 characterized by having an insulating layer additionally in a **** side, or support of one publication of four.

[Claim 6] Support of the claim 5 publication characterized by an insulating layer consisting of an oxide of nickel, Fe, Cr, Co, Nb, Mo, Ta, W, Re, Os, Ir, Tc, or V.

[Claim 7] Support of the claim 5 publication characterized by forming the insulating layer with the 2nd alloy which mainly consists of silver similarly, and this having the close oxide enveloping layer.

[Claim 8] Support of the claim 7 publication characterized by the 2nd silver alloy containing especially at least one of Si, Be, aluminum, or the Mg other than silver 0.2 to 2% of the weight 0.2 to 5% of the weight.

[Claim 9] Support of the claim 7 publication characterized by the 2nd silver alloy containing Sn and/or Zn other than silver one to 10% of the weight.

[Claim 10] Support of the claim 7 publication characterized by the 2nd silver alloy containing [Cd] 0.05 - 1 % of the weight, and/or Zn for 5 - 15 % of the weight and aluminum other than silver 0.05 to 2% of the weight.

[Claim 11] Support for superconducting coils characterized by being formed with the alloy with which support mainly consists of silver in the support for the superconducting coil which has **** which consists of long superconduction complex, and this silver alloy having the close oxide enveloping layer.

[Claim 12] Support of the claim 11 publication characterized by the silver alloy containing especially at least one of Si, Be, aluminum, or the Mg other than silver 0.2 to 2% of the weight 0.2 to 5% of the weight.

[Claim 13] Support of the claim 11 publication characterized by the silver alloy containing Sn and/or Zn other than silver one to 10% of the weight.

[Claim 14] Support of the claim 11 publication characterized by the silver alloy containing [Cd] 0.05 - 1 % of the weight, and/or Zn for 5 - 15 % of the weight and aluminum other than silver 0.05 to 2% of the weight.

[Claim 15] The claim 1 characterized by being the oxidization ceramic superconductor which has the outside sleeve which superconduction complex becomes from silver or a silver alloy, or support of one publication of 14.

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DETAILED DESCRIPTION

[Detailed description]

[0001]

[Field of the Invention] this invention relates to the support for superconducting coils which has **** which consists of long superconduction complex.

[0002]

[Prior art] For example, together with a classic superconductor like Nb-Ti and Nb₃Sn, the superconduction complex of the format that oxidization ceramic superconduction powder was surrounded by the sleeve material is known for recently. Such oxidization ceramic complex is indicated in the publication "metal (METALL)" by ***** (H. Krauth) and ***** (A. Tzulczyk), the 45th volume, the 5th edition, 1989 after the 418th page. The phase of the system of YBaCuO, BiSrCaCuO, and TlBaCaCuO is mentioned as especially suitable oxidization ceramic matter.

[0003] For making an industrial-use superconductor, this oxidization ceramic powder is stuffed into a metallic conduit, and this is manufactured on a wire rod or a tape. Especially since the oxygen permeability needed as a material of a metallic conduit is guaranteed, it is proved that silver or the silver alloy is suitable (refer to the Europe patent-application public presentation of No. 290331, the Federal Republic of Germany patent-application public presentation of No. 3731266, and the Federal Republic of Germany patent-application public presentation specification of No. 4104421). The silver alloy by which the dispersion hardening was carried out to the Federal Republic of Germany patent-application public presentation specification of No. 4104421 is proposed as a sleeve material. The amount of additives of an alloy does not pass to 0.005 - 2% of the weight especially in that case, but 98% of the weight or more of AgMgNi, AgMnNi, and AgAl alloy are advantageously mentioned for the silver content. These alloys have the mechanical property which was [stiffness / a higher degree of hardness,] excellent in comparison with virgin silver.

[0004] Furthermore, it is already known that **** for coils can be manufactured with an oxidization ceramic superconduction compound wire rod from the Europe patent-application public presentation specification of No. 406862. It gives on support, using oxidization ceramic complex as **** for that purpose. A **** unit is succeeding heat-treated at the temperature of about 900 degrees C, and the superconduction property of a compound wire rod is adjusted.

[0005]

[Object of the Invention] By the way, when manufacturing a coil with an oxidization ceramic compound superconductor, in case support is cooled from the last heat treatment temperature (about 900 degrees C) to the service temperature of 77K or 4.2K, in order not to make the maximum permission expansion coefficient for an oxidization ceramic compound wire rod exceeded, it has become clear that it is necessary to have the coefficient of thermal expansion which support fitted to the compound superconductor. Moreover, support should have sufficient electric resistance for advantageously high stiffness and/or the insulation to the **** side by being few. Therefore, the technical problem of this invention is to offer such support.

[0006]

[The means for solving a technical problem] This technical problem is solved by the support which has the claim 1 or the characteristic feature of 11. The advantageous embodiment is indicated by other claims.

[0007]

[The operation effect] According to the claim 1, the dispersion hardening of the support is carried out in the oxide which mainly consists of silver as a material, or it contains the alloy which can be hardened. It has the coefficient of thermal expansion which is equal to the coefficient of thermal expansion of the oxidization ceramic compound wire rod which has the sleeve which this alloy becomes from silver or a silver alloy by the high silver content. That is, it has become clear that it is what the coefficient of thermal expansion of a compound wire rod is mainly determined by the sleeve material, therefore is fully equal to a silver coefficient of thermal expansion. It is fully equal to a silver coefficient of thermal expansion by the high silver content of the coefficient of thermal expansion of the support by this invention, i.e., the alloy used. Therefore, it is possible to hold the expansion coefficient produced in case it cools from the last heat treatment temperature to the service temperature of 77K or 4.2K below to about 0.2% of a critical value. The silver alloy which is especially indicated by the Federal Republic of Germany patent-application public presentation specification of No. 4104421 and by which the dispersion hardening was carried out can be used for this support. These silver alloys have a high degree of hardness and high stiffness in the status that it hardened. AgMg, AgMgNi, AgMnNi, and AgAl alloy are used especially in that case. In the case of AgMg and AgMnNi alloy, these contain 0.1 - 0.25% of the weight of Mg, and 0.1 - 0.25% of the weight of nickel advantageously besides silver. In the case of AgMnNi alloy,

Mn and nickel are combined, and what is the remaining silver is advantageous 0.5 to 1.5% of the weight. Advantageous AgAl alloy contains 0.05 - 0.6% of the weight of aluminum other than silver. It is possible to manufacture the support which the dispersion hardening of the oxide was carried out [support], or had the stiffness other than conformity of coefficient of thermal expansion raised by the alloy which can be hardened.

[0008] on the other hand -- for example, when stiffness seldom becomes a problem like the coil which does not receive a special mechanical load comparatively like a parvus field or **** for a test, the alloy which has the close oxide enveloping layer indicated by claims 11-14 especially as a material for support and which mainly consists of silver can also be used. Electric resistance is raised by the oxide enveloping layer not only coefficient of thermal expansion is raised by the high silver content, but, therefore the support equivalent to this is insulation. In this case, especially the silver alloy that contains especially at least one of Si, Be, aluminum, or the Mg other than silver 0.2 to 2% of the weight 0.2 to 5% of the weight is advantageous. Furthermore, the silver alloy containing 1 - 10% of the weight of Sn and/or Zn other than silver also serves as an object. Moreover, AgCd alloy of 5 - 15 % of the weight of Cd contents which can make a close oxide enveloping layer by addition of the small amount of 1 or less % of the weight of aluminum and/or 2 or less % of the weight of Zn also serves as an object.

[0009] Especially the support containing the thin insulating layer which has the close oxide enveloping layer of the 2nd product made from an alloy which a dispersion hardening is mainly carried out in the above-mentioned oxide, or consists of an alloy which can be hardened, and mainly becomes the **** side from silver at least additionally again is advantageous. However, this insulating layer may consist of an oxide of nickel, Fe, Cr, Co, Nb, Mo, Ta, W, Re, Os, Ir, Ru, Tc, or V again. This insulating layer is realizable also by having the thin tape or thin film to which support changes from the alloy with the elements to which the mixing of the above-mentioned silver cannot be carried out, or these elements. In case it heat-treats in the oxygen inclusion ambient atmosphere, a material oxidizes and makes an insulating layer. Such support suits coefficient of thermal expansion, has stiffness raised again, and has insulation.

[0010] The dispersion hardening of the oxide used by this invention is carried out, or, in the case of the silver alloy which can be hardened, hardening is performed by the internal oxidation. An internal oxidation is produced with heat treatment in air or the oxygen inclusion ambient atmosphere. In that case, hardening may be performed, before are carried out along with the time of the above-mentioned last heat treatment or giving **** to support. Magnesium-oxide grain will be separated, a case, for example, heat treatment, of AgMgNi alloy. Detailed-ized variance of this hard component gives high stiffness to an alloy. A nickel component is useful to detailed-ization of grain by restricting the fusibility to the inside of silver. When not hardening (the stiffness in that case may be equal to the stiffness of virgin silver), it is twice [about] the stiffness of AgMgNi alloy of the status that it hardened of this. The degree of hardness of standard AgMgNi alloy of 130HVs is already also clearly higher than that (about 80 HVs) of virgin silver at a room temperature. However, when an alloy is heat-treated at higher temperature, a difference becomes much more large. Although the virgin silver after heat treatment has the degree of hardness of 25HVs at 600 degrees C, on the other hand, the degree of hardness of above-mentioned AgMgNi alloy which already oxidized fully does not change substantially.

[0011]

[Example] this invention is explained in full detail below based on a drawing.

[0012] Drawing 1 is the cross-sectional view of the support for superconducting coils by this invention, and support is formed in the shape of a hollow cylinder. The inside fraction 1 of support consists an oxide of an alloy by which the dispersion hardening was carried out. The **** side is equipped with the supplementary layer 2 for giving insulation. This layer 2 is made from the alloy which mainly consists of silver, and this has a close oxidation enveloping layer (not shown in drawing).

[0013] Next, AgAl2 alloy of 2% of the weight of aluminum and the remaining silver is described as an example of the alloy to which the close oxidation enveloping layer was given and which mainly consists of silver. For this reason, it experimented with the ****ing sheet metal with a thickness of about 1mm. Sheet metal was heat-treated at the temperature of 800-870 degrees C. The layer which becomes the front face from aluminum₂O₃ with this heat treatment is made, a thickness comes out enough and, in a certain case, this commits an insulating layer with the high electric resistance of an aluminum oxide. As long as the material contains the aluminum which does not oxidize in addition to the interior, processing temperature is restricted to the solidus-line temperature of AgAl2 about 880-degree C alloy.

[Translation done.]